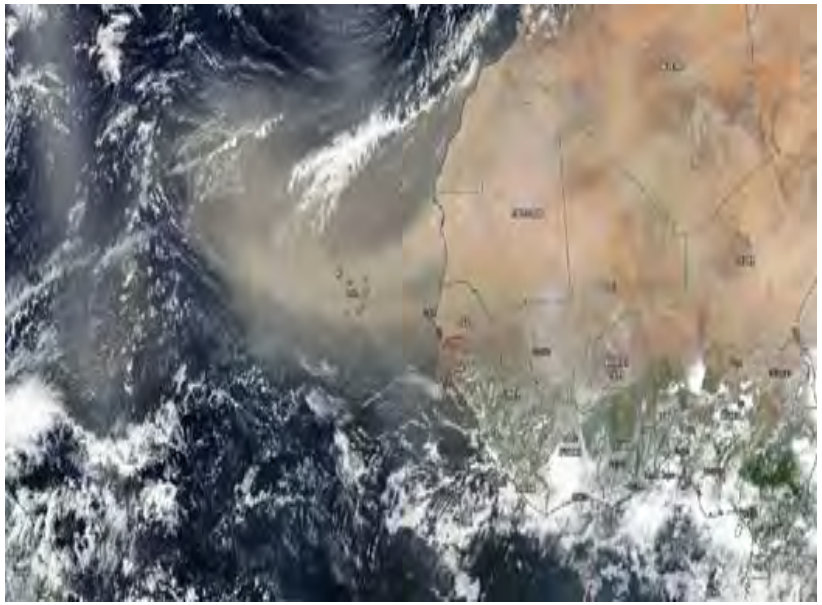


The 4D-Atlantic Dust and Ocean Modelling and Observing Study (DOMOS)

Stephanie Fiedler, University of Cologne

DOMOS is carried out under a programme of, and funded by, the European Space Agency. The view expressed in this presentation can in no way be taken to reflect the official opinion of the European Space Agency

The DOMOS Team

ECMWF

Lead

A. Benedetti

T. Warnaars

J. Letertre-Danczak

M. Ades

L. Steele

Z. Kipling

MetNo

S. Tyro

J. Griesfeller

NIOZ

J.-B. Stuut

UoC

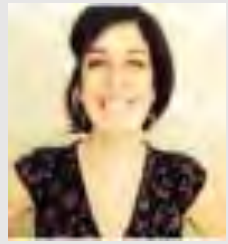
S. Fiedler

V. Varma

BSC

M. Gonçalves

C. Perez Garcia-Pando



E. Di Tomaso

J. Escribano

E. Bergas

S. Basart

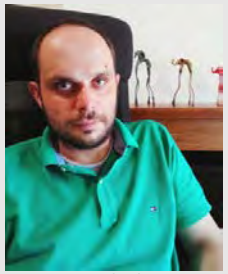
J. Llort

R. Bernardello

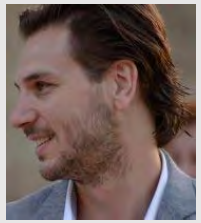
P. Ortega

V. Lapin

NOA



A. Gkikas



S. Myriokefalitakis

V. Amiridis

E. Proestakis

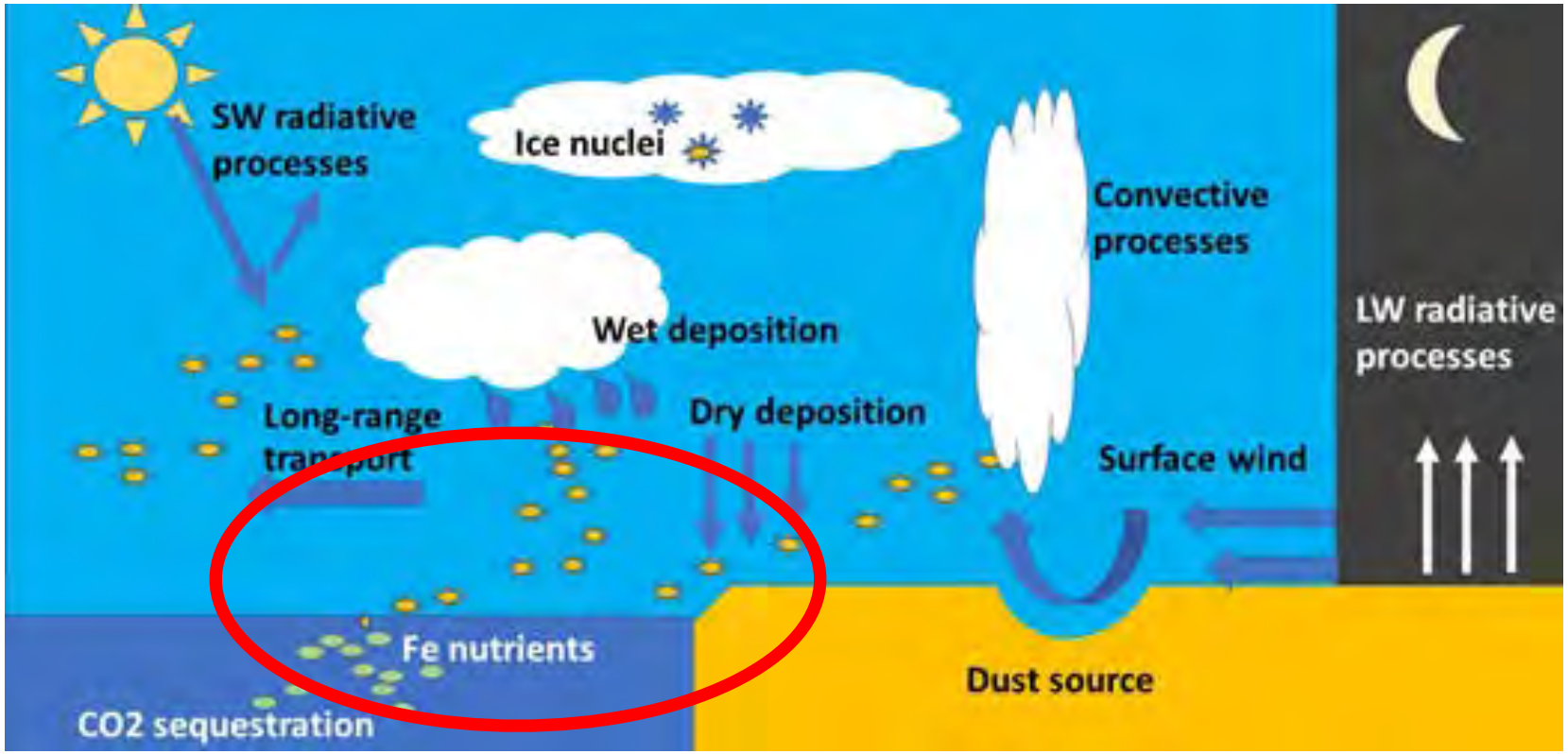
E. Marinou

DOMOS

Motivation

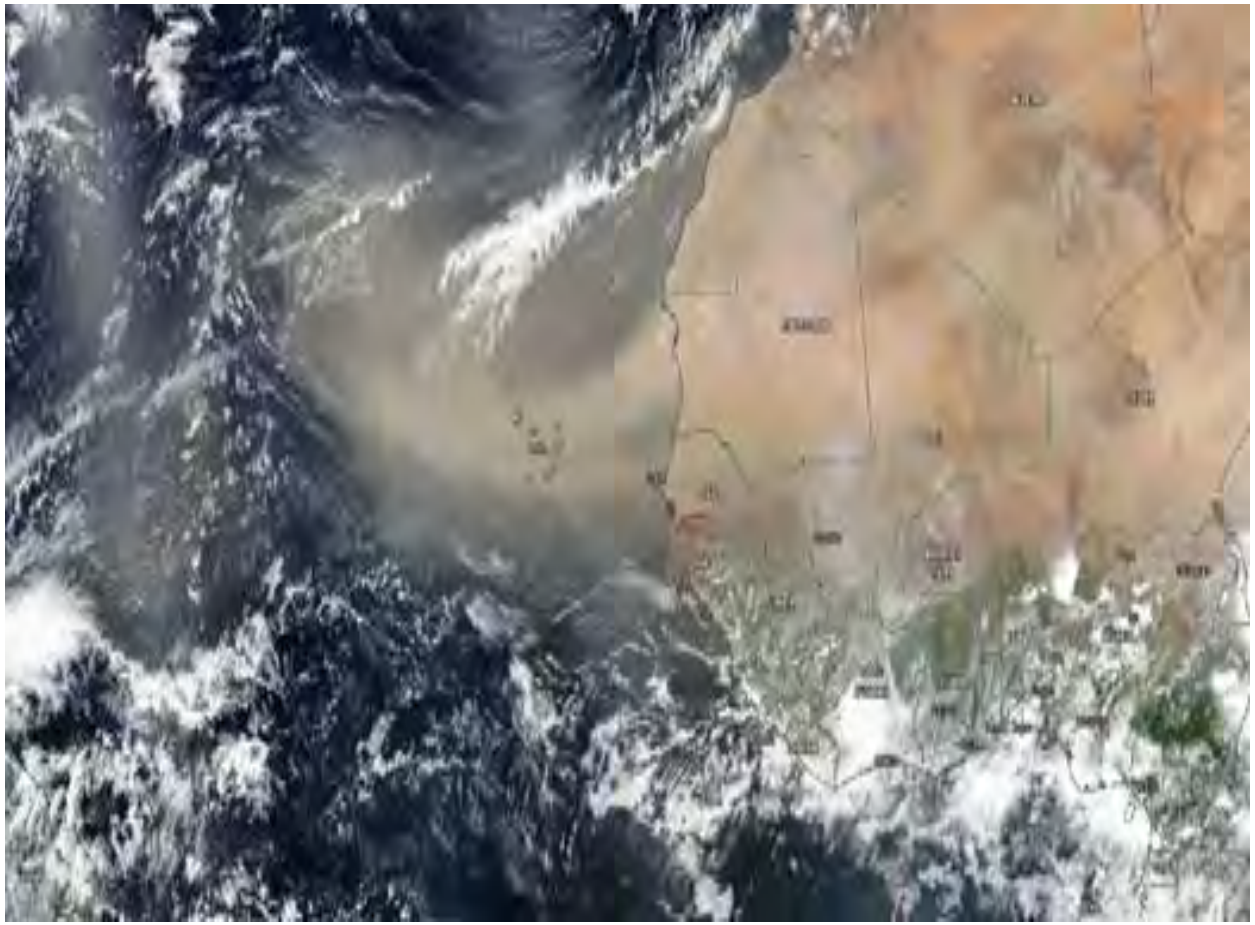
Desert dust is a key player in the Earth System.

DOMOS addresses **dust interactions with the ocean** using an **integrated modelling and observing approach**



DOMOS

Science questions



1. To what extent **dust deposition** over the Atlantic has changed over the **last 20 years**? Can we identify robust **trends** in the reanalysis and model datasets and if yes, how can we verify them?

2. What is the contribution of **anthropogenic and natural sources** of dust compared to biomass burning and anthropogenic aerosols to soluble **iron** deposition over the Atlantic?

3. What are the **impacts** of changes in dust deposition on marine **biogeochemistry** and their potential effects on **ecosystems**?

DOMOS

DOMOS objectives

1. To collate available **observations from ESA platforms and other sources** and utilise/collect new ones from in-situ (mooring buoys, ground-based observing sites) and research vessels in order to provide a complete picture of dust deposition processes with focus over the Atlantic ocean.

2. To create a **unique 4D-reconstruction of the dust full cycle** including deposition based on the synergy of models and observations including vertical profiling through the use of advanced retrieval methods and of 4D-Var and Ensemble Kalman Filter analyses.

3. To **advance our understanding of the trends in dust deposition** over the Atlantic Ocean by exploiting observations, model simulations and existing atmospheric reanalysis.

4. To generate and evaluate **state-of-the-art model reconstructions of the atmospheric iron cycle and of its impact upon ocean biogeochemistry,** including the contribution of anthropogenic and natural dust and other sources of soluble iron deposition.

5. To **demonstrate the added value of this novel approach** and identify any gaps in the observing system that need to be filled in order to have a complete picture of interactions between atmospheric dust and ocean.

6. To **provide a scientific roadmap and work in collaboration with early adopters** and stakeholders with strong focus on scientific and technical inputs for actionable mitigation strategies as well as new EO science-based solutions.

DOMOS

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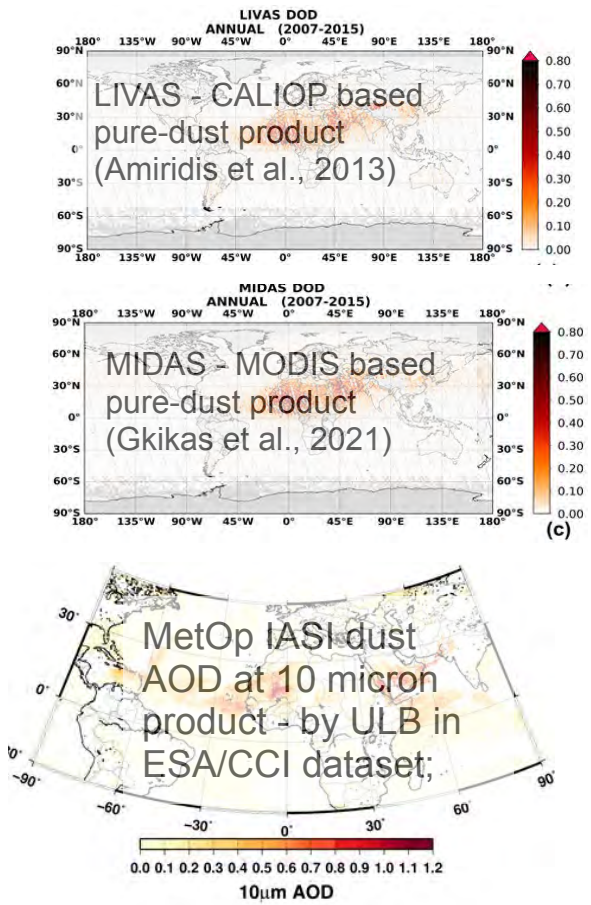
DOMOS

Observations from ESA platforms and other sources

Observational data

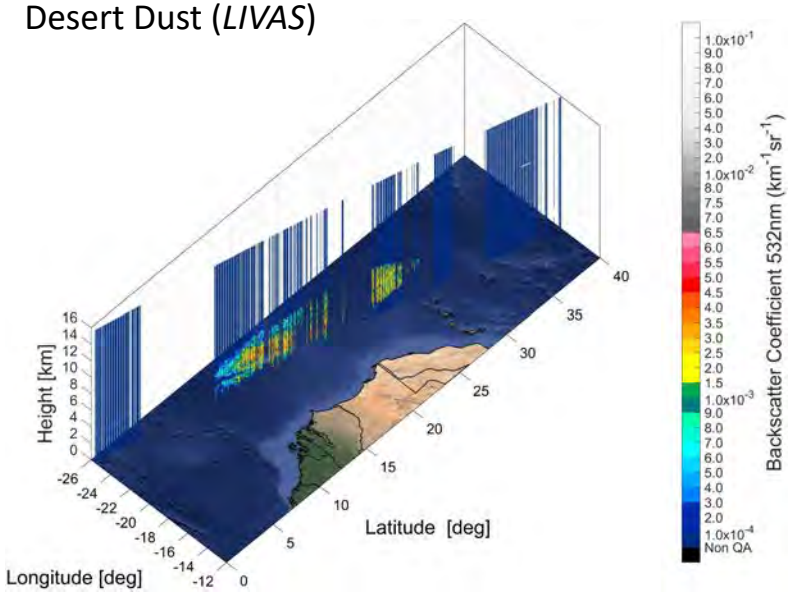
Dust optical depth



Sentinel-3 OLCI and SLSTR Synergy - L2 DOD 550nm

Dust plume vertical extent

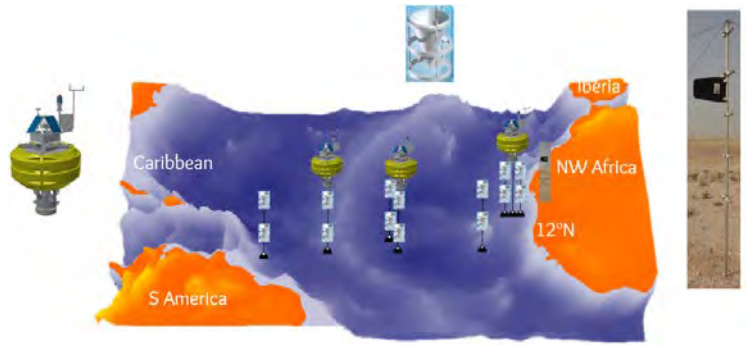
Desert Dust (*LIVAS*)



Amiridis et al., 2013
Marinou et al., 2017
Proestakis et al., 2018

Ocean-based measurements

Dust deposition from buoys



Ship-based aerosol optical depth

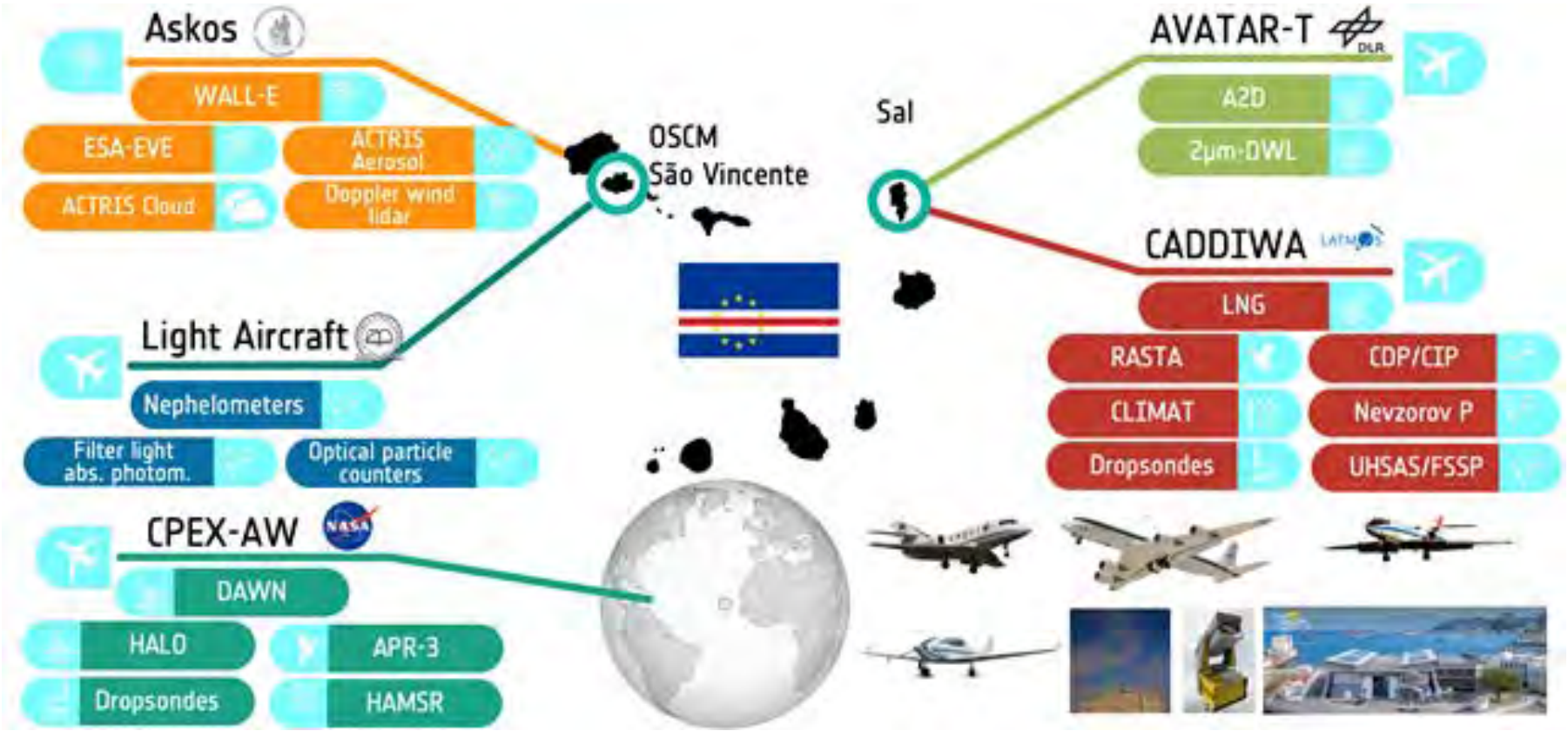
https://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html

DOMOS

ASKOS Experimental Campaign in summer 2021

Objectives:

- Evaluate Aeolus aerosol product for dust and marine aerosols
- Estimate the uncertainty in Aeolus backscatter
- Estimate the impact of particle orientation for mineral particles and ice crystals



https://askos.space.noa.gr/

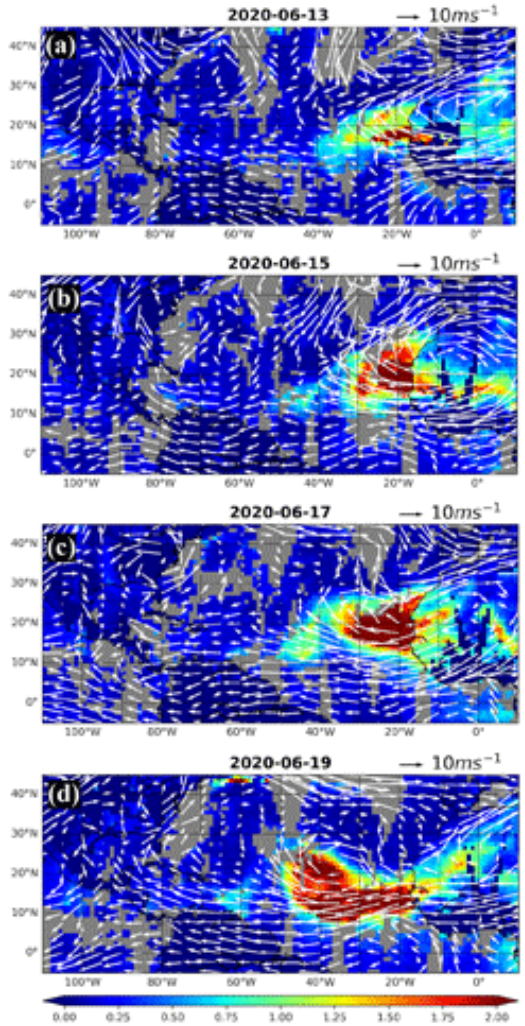
DOMOS

Modeling and Observing case study of dust outbreak in June 2020

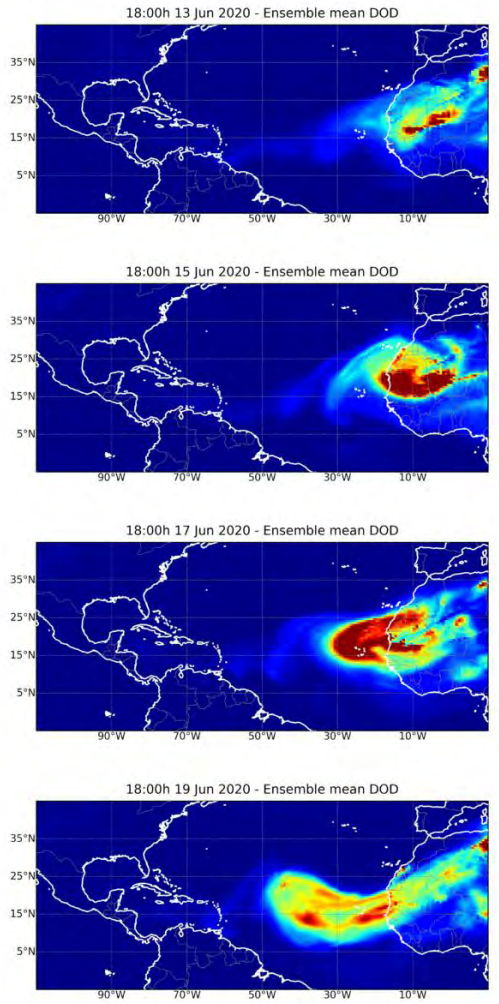
MONARCH ensemble forecasts

Main characteristics of event reproduced with some misplacement of the plume and underestimation of the intensity of the dust event

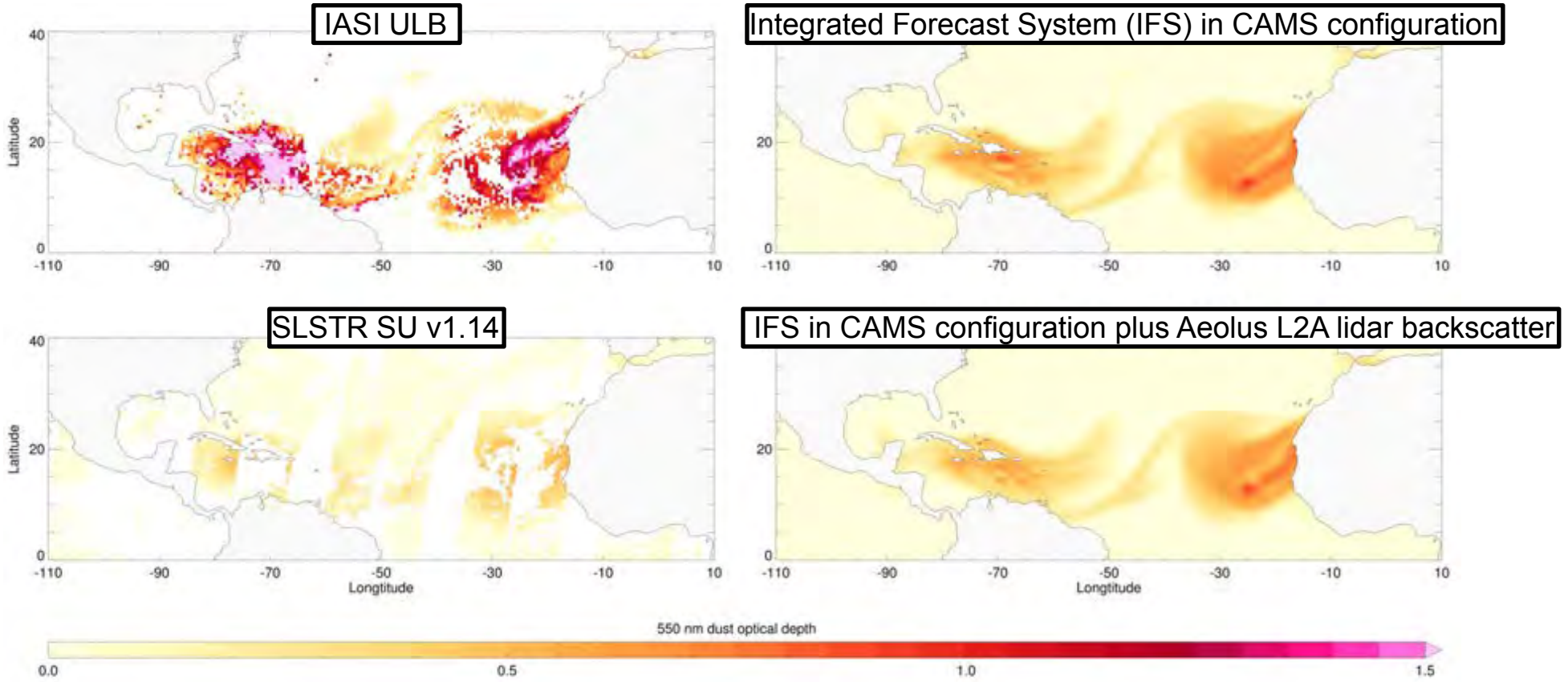
MODIS (daily, Terra and Aqua, Yu et al. 2021)



MONARCH free-run ensemble mean



Use of Aeolus L2A data (23 June 2020)

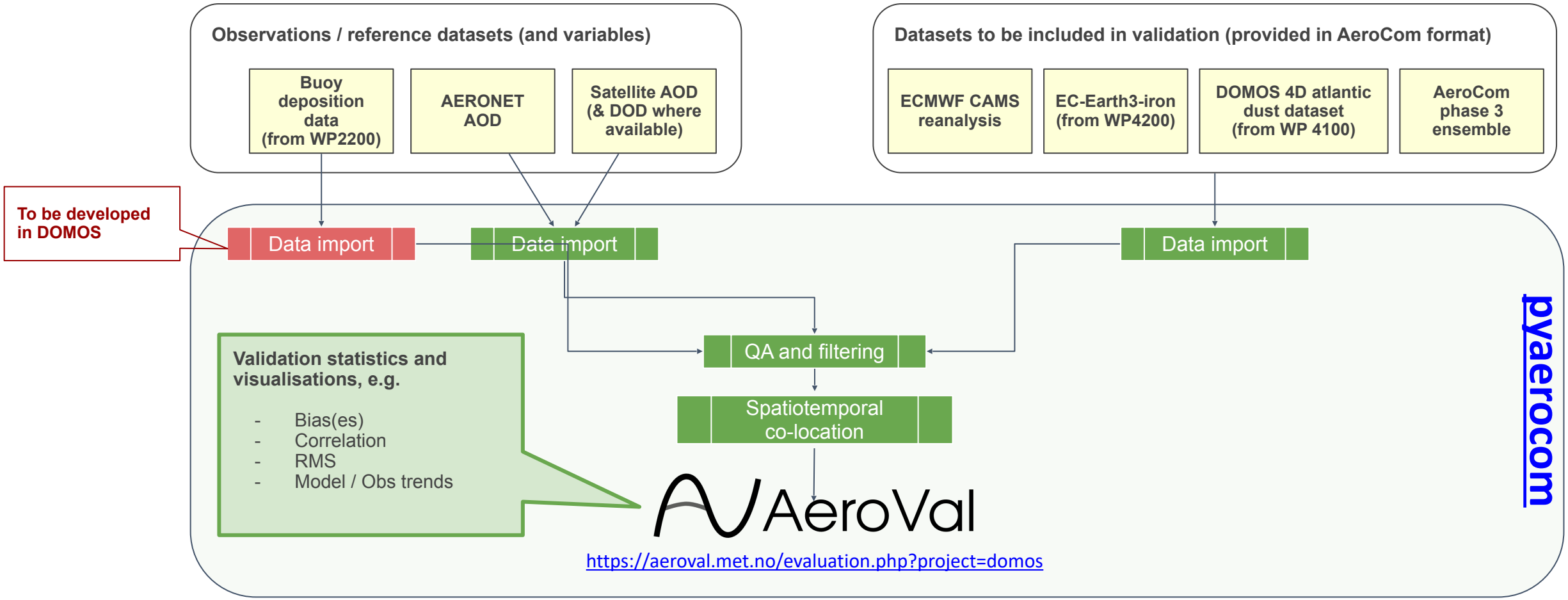


Observational datasets differ substantially due to sensitivity to dust particles of different sizes

Plots courtesy of Liam Steele

DOMOS

Model evaluation tools



https://aeroval.met.no/evaluation.php?project=domos

DOMOS

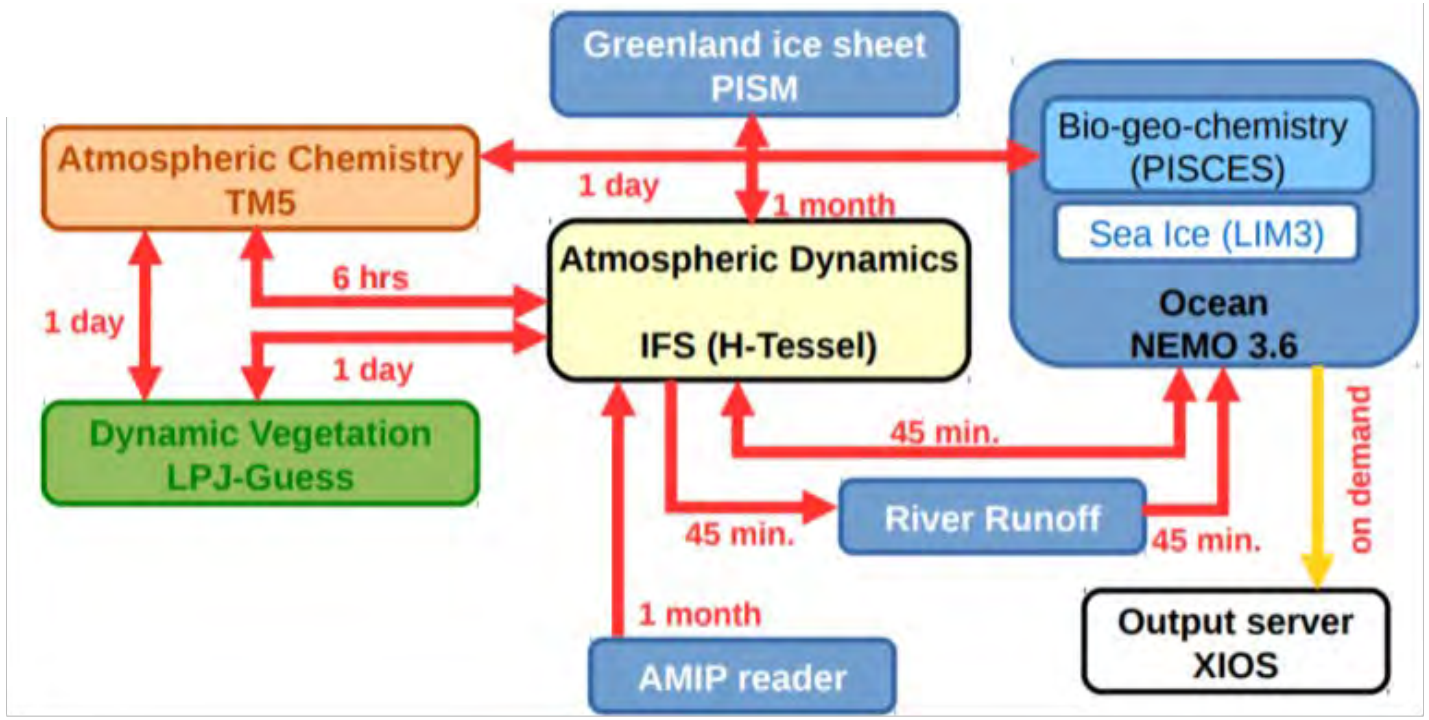
Modeling and Observing iron depositions

Model-based dust and iron deposition climatologies

Earth system model EC-Earth3 (Hazeleger et al., 2012; Döscher et al. 2021) also used in CMIP6

The **EC-Earth3-AerChem** (Van Noije et al., 2014; 2021) explicitly simulates **tropospheric aerosols, methane, and ozone** through the TM5 module.

TM5 is coupled to the atmospheric dynamics (represented by IFS). Ocean state can be simulated (through NEMO) or prescribed (via AMIP reader).



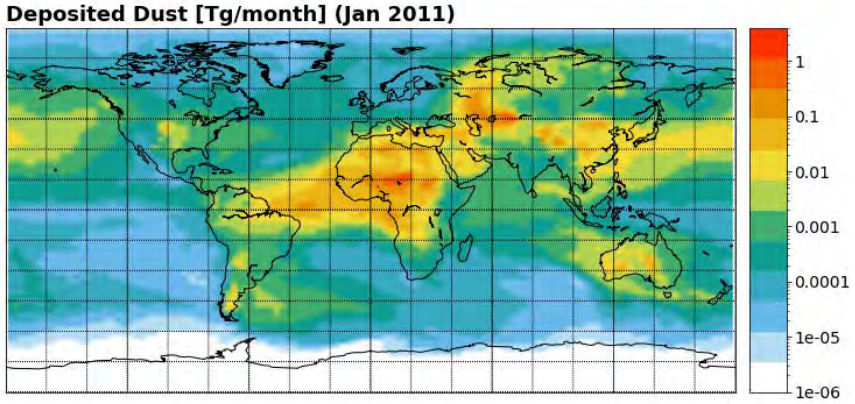
Schematics of the EC-Earth version 3 components and the coupling frequency between them.

Image from Le Sager (2019), EC-Earth meeting.

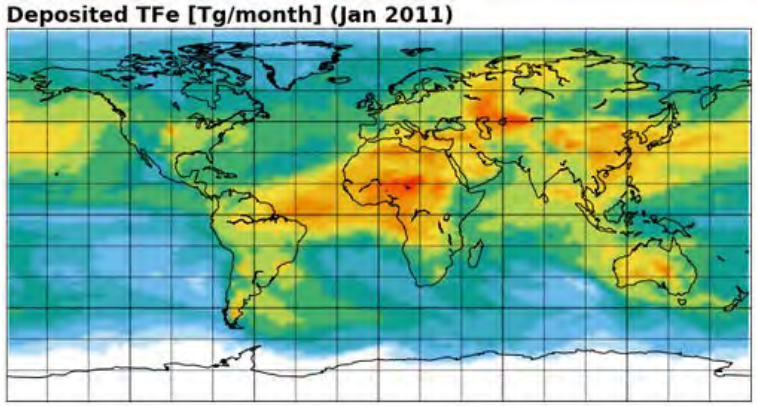
Model-based dust and iron deposition

January 2011 output of EC-Earth3-Iron experiment nudged to ERAInterim.

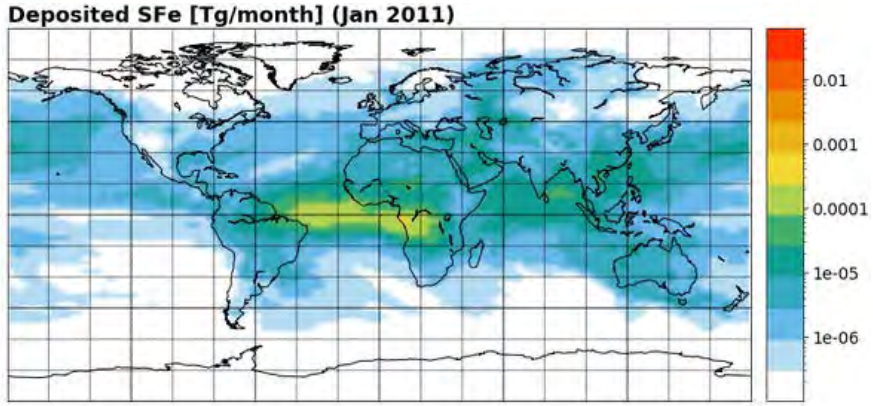
Dust deposition



Total iron deposition

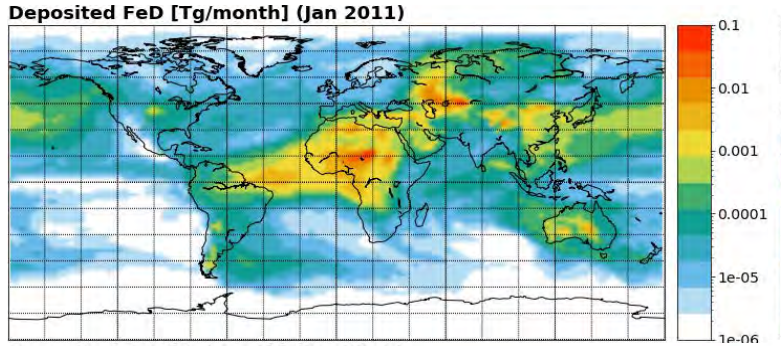
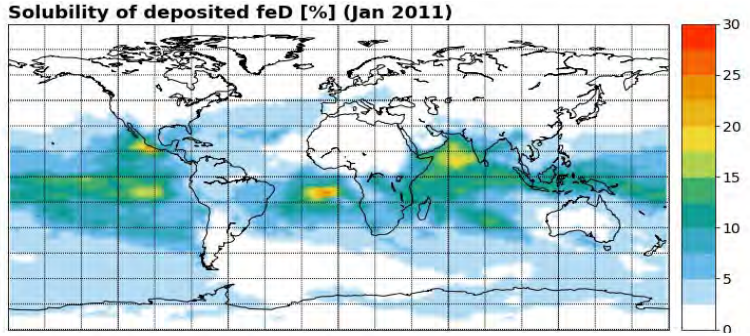
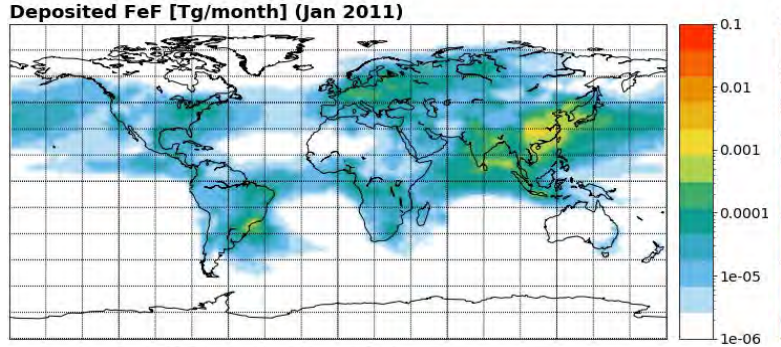
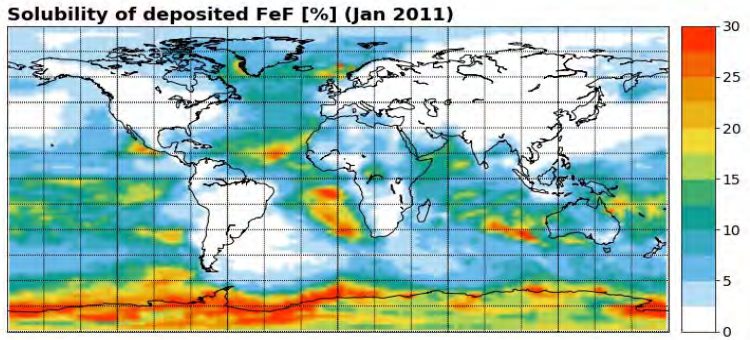
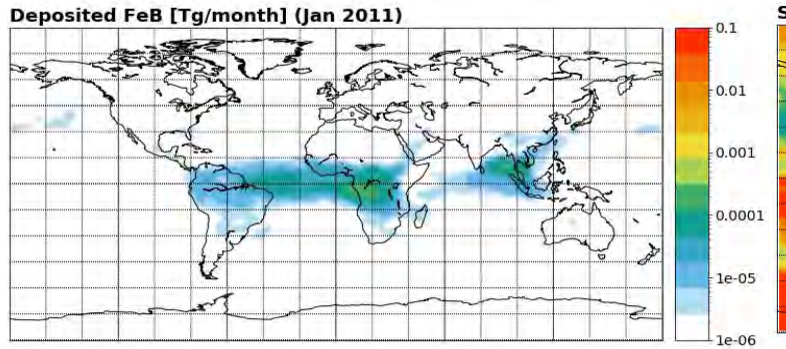
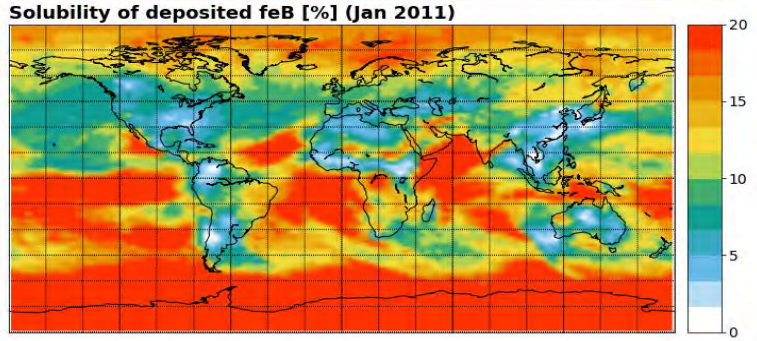


Soluble iron deposition

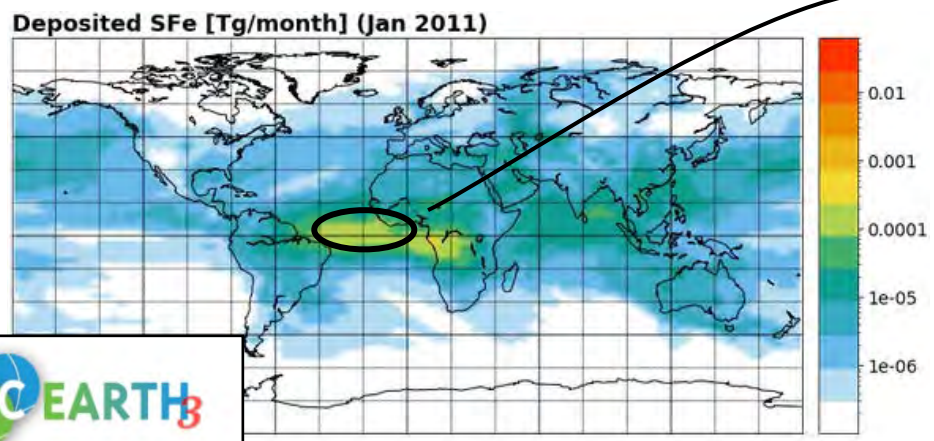


Model-based iron deposition by different aerosol species

January 2011 output of EC-Earth3-Iron experiment nudged to ERAInterim.

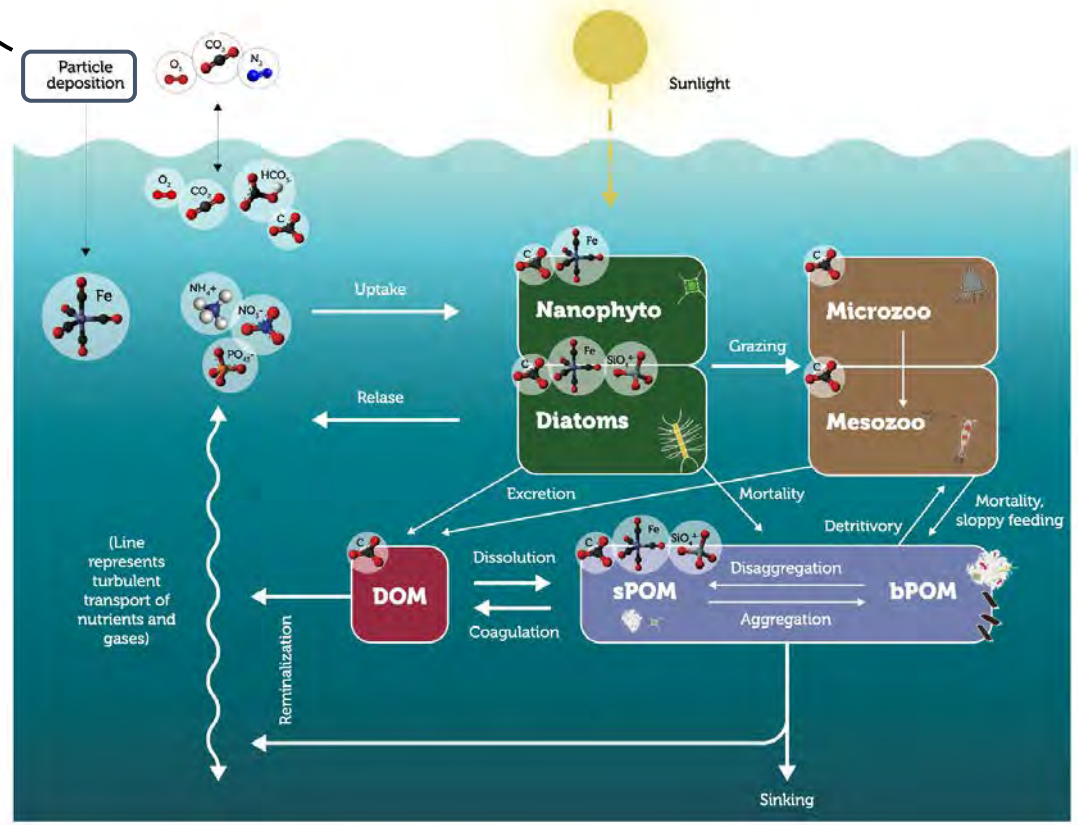
	Fe deposition	Solubility of Fe deposition
Fe-Dust		
Fe-Anthr.Comb		
Fe-BB		

Reconstruction of ocean biogeochemistry with new iron deposition



Soluble iron fields from EC-Earth3 will be used to estimate the particle deposition flux in PISCES

Biogeochemical ocean model PISCES



DOMOS

DOMOS Dissemination

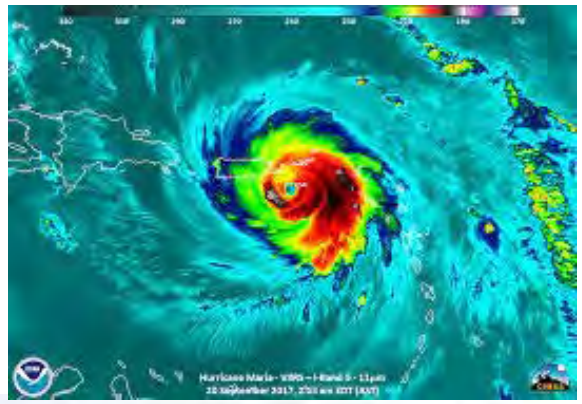
SCIENTIFIC RESULTS

- ✓ Publications
- ✓ Conferences
- ✓ New collaborations

POTENTIAL USER'S APPLICATIONS

- ✓ Risk identification
- ✓ User engagement

Hurricanes prediction



Fishering

Algae Blooms

CAPACITY BUILDING

- ✓ Training
- ✓ Access data
- ✓ Dissemination - News

esa

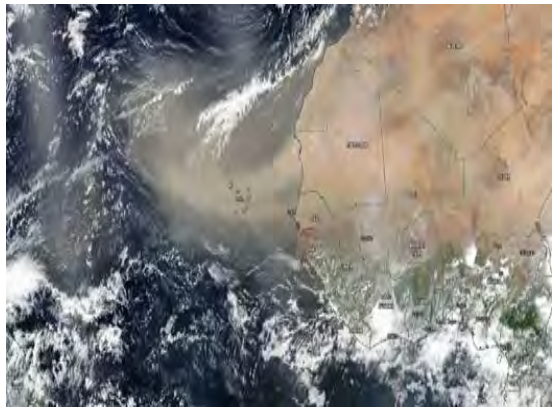
European Space Agency

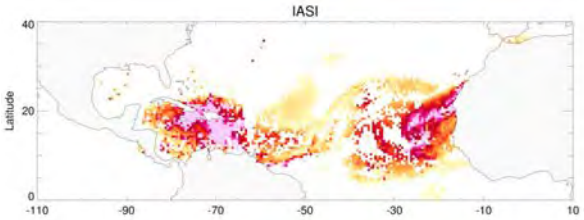
WMO Barcelona Dust Regional Center

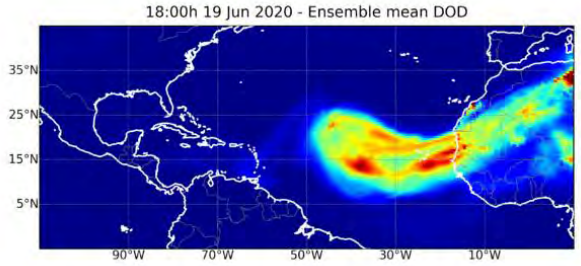
Copernicus

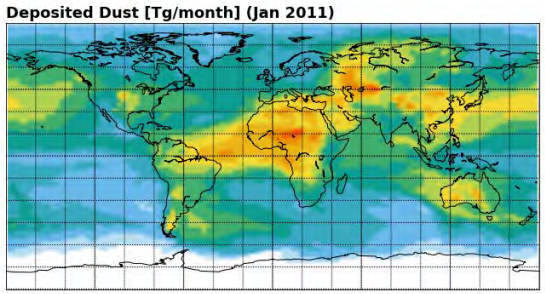
Fill in the Survey to let us know your interest in our project!

DOMOS









The 4D-Atlantic Dust and Ocean Modelling and Observing Study

Want to get in touch?

Access to DOMOS survey via QR code:

Stephanie Fiedler
stephanie.fiedler@uni-koeln.de

Project lead: Angela Benedetti
angela.Benedetti@ecmwf.int

ECMWF · Barcelona Supercomputing Center · NIOZ · Universität zu Köln · Norwegian Meteorological Institute · DOMOS